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(54) A method of mounting doors on motor vehicle bodies and equipment for carrying out such method.

(57) A method of mounting doors automatically on a motor-vehicle body provides for the use of a locating robot (10) with a frame (12) for gripping the doors, the frame (12) carrying first television cameras (20) for piloting its precise location and second televison cameras (22) for piloting robots (14,16) for welding or bolting the hinges (40) once the door has been located.

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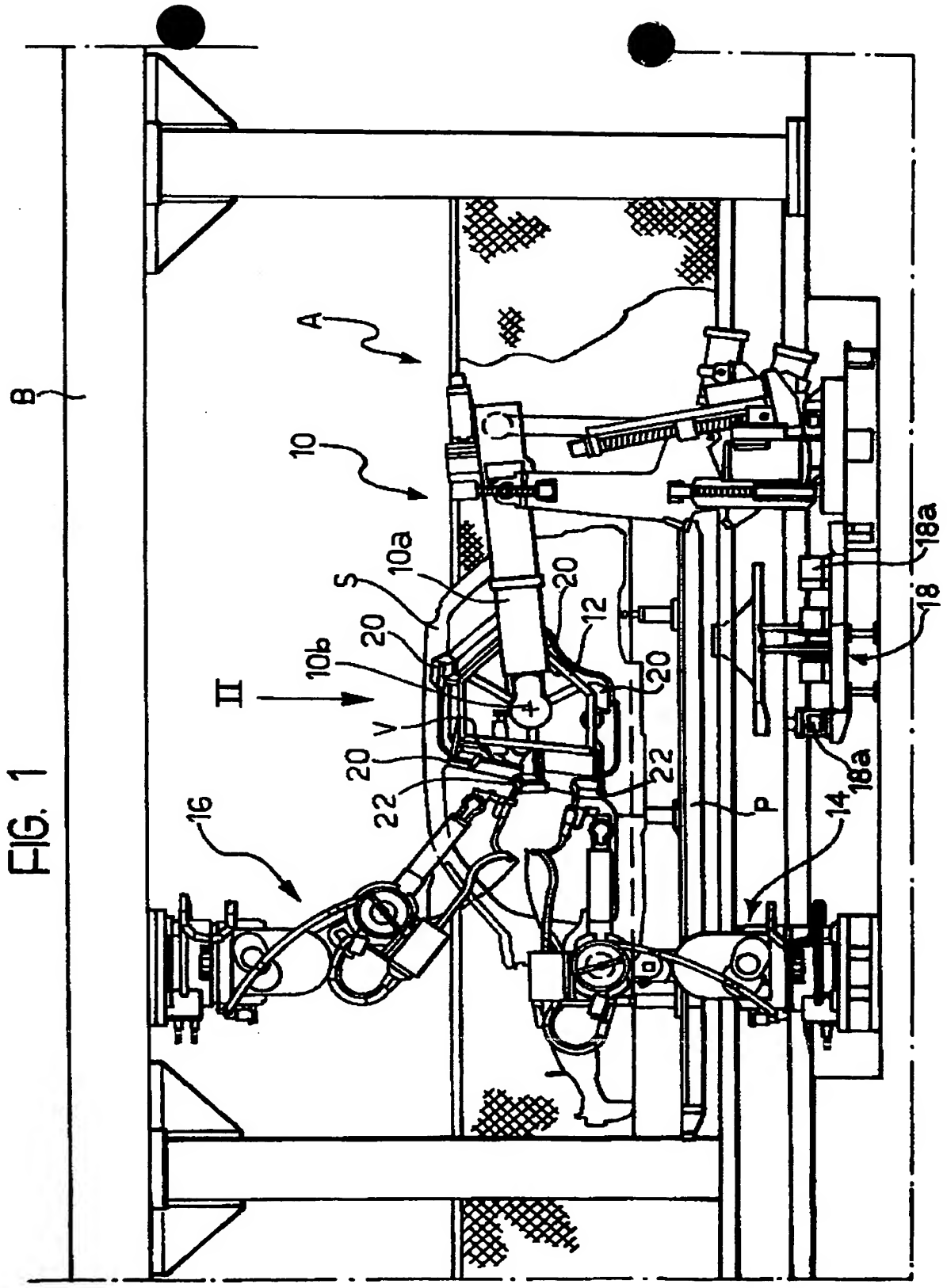


FIG. 1

The present invention relates to a method of mounting doors automatically on motor-vehicle bodies.

At present, the doors are positioned manually on the motor-vehicle body before the hinges are fixed. Only the fixing of the hinges to the body, for example by welding, is automated.

This obviously involves the use of more labour and more time for each door-mounting cycle, to the detriment of the cost of the operation.

The object of the present invention is to provide a method which enables the door-mounting cycle to be fully automated.

According to the invention, this object is achieved by virtue of the fact that the method includes the following steps: providing a robot having an arm with grippers associated with first and second televisual image-detection means, locating the arm of the robot in a reference position in front of a door opening in a motor-vehicle body, acquiring data relating to the position of the periphery of the door opening in space by means of the first image-detection means, taking a door from a store by means of the grippers of the arm of the robot, acquiring data relating to the position of the periphery of the door relative to the grippers by means of the first image-detection means, processing the data resulting from the detection of the periphery of the door opening by comparing it with the data resulting from the detection of the periphery of the door, varying the position of the robot arm relative to the reference position as a result of the processing, locating the door in the corresponding door opening, acquiring data relating to the positions of the hinges relative to the body by means of the second image-detection means, and fixing the hinges of the door to the motor-vehicle body by means of auxiliary robots subservient to the second image-detection means.

The use of the known technique of detecting images by means of a television camera in association with the use of two different robots, one for locating the door in the door opening and one for automatically welding or bolting the hinges to the body, enables the door-mounting cycle to be fully automated and at the same time reduces the time required for this operation.

For vehicles with four doors, the equipment for carrying out the method includes two assembly stations each with two locating robots situated on opposite sides of the line along which the body advances and four welding robots arranged in pairs on each side of the path of the body, each pair being constituted by a floor-mounted robot and an upper robot supported by a portal structure.

Further advantages and characteristics of the method and the equipment according to the invention will become clear from the detailed description which follows, purely by way of non-limiting example, with reference to the appended drawings, in which:

Figure 1 is a side view of a first assembly station for mounting doors on a motor-vehicle body,

Figure 2 is a view taken on the arrow II of Figure 1,

Figure 3 is a view similar to Figure 1 and shows a second assembly station for mounting doors on the body,

Figure 4 is a view taken on the arrow IV of Figure 3,

Figure 5 is a schematic view showing a first step of the method according to the invention,

Figure 6 is a schematic view showing a second step of the method according to the invention,

Figure 7 is a schematic view showing a third step of the method according to the invention,

Figure 8 is a schematic view showing a fourth step of the method according to the invention,

Figure 9 is a schematic view showing a fifth step of the method according to the invention,

Figure 10 is a plan view of the frame for supporting the door,

Figure 11 is a side view of the frame of Figure 10, and

Figure 12 is a section taken on the line XII-XII of Figure 10.

With reference to the drawings, a motor-vehicle assembly line, generally indicated A, includes a plurality of pallets P on which a plurality of bodies S are mounted, Figures 1 and 2 show a first assembly station for mounting doors in rear door openings V in a body S of a four-door motor vehicle. The first assembly station for mounting the rear doors has a pair of assembly robots 10 arranged on opposite sides of the line A and each having an arm 10a whose end has a wrist 10b on which a metal gripping frame 12 known as a "gripper" is mounted. The first assembly station also includes two pairs of welding robots arranged on opposite sides of the line A, each pair including a first welding robot 14 on the floor and a second welding robot 16 which is supported by a portal structure B associated with the assembly line A.

As can clearly be seen in Figure 2, storage racks M are arranged beside the line A for supporting a plurality of rear doors D_1 and, on each side of the line A, there is a calibration device 18, whose function will become clear from the following description.

Figures 3 and 4 show a second assembly station for mounting front doors D_2, in which the arrangement of the assembly robots 10 and the welding robots 14 and 16 is substantially identical to that of the first assembly station.

The particular characteristic of the method of mounting the rear doors D_1 and the front doors D_2, which are generally indicated D, consists of the use of four television cameras 20 for each assembly robot 10, the cameras being fixed to the metal frame 12 which picks up the doors and being adapted to provide signals indicative of the position of the arm 10a

of the robot 10 relative to the door opening V and to the position of the periphery of the door supported by the frame 12. There are also two auxiliary television cameras 22 for piloting respective welding robots 14 and 16 during the fixing of the hinges to the body S.

The gripper frame 12 is shown in detail in Figures 10-12 but, for clarity, the television cameras 20 and 22 are not shown therein. The gripper frame 12 has a substantially flat metal structure 12a made of metal sections welded together, to which brackets 12b projecting from the plane identified by the metal structure 12a are fixed. Suction cups 26 of known type are mounted on the metal structure 12a for cooperating with a convex surface F of the door D. Clamping levers 30 operated by jacks 32 and also articulated to the ends of the brackets 12b at 28 are adapted to cooperate with the periphery of the window opening, indicated E. Similarly, each of two shaped levers 36 (Figure 12) articulated to the metal structure 12a of the gripper frame 12 at 34 has a portion 36a connected to an operating jack 38 and a second portion 36b which is adapted to cooperate with a flange 40a of a hinge 40 of the door D so as to locate it in the correct position for fixing to the body. The metal structure 12a of the gripper frame 12 is fixed to the wrist 10b of the assembly robot 10 at 42.

The assembly method according to the invention is illustrated in Figures 5-9. When a motor-vehicle body reaches a predetermined position on the assembly line A, the robot 10 locates the frame 12 in a reference position at the door opening V (Figure 5), according to a predetermined operating program, so that the television camera 20 can supply the central processing unit of the robot with data indicative of the position of the periphery of the door opening V.

The arm 10a of the robot 10 with its gripper frame 12 is then positioned beside the storage rack M on which a door D is disposed (Figure 6). A vacuum source (not shown) is put into communication with the suction cups and jacks 32 are operated so that the door D is made fast with the frame 12.

The arm of the robot 10 is then located in a predetermined position in front of the door opening V (this position corresponds to that in which the "reading" of the door opening V was carried out) so as to enable the television cameras 20 to detect the position of the door D relative to the frame. A second batch of data is then sent and a second processing operation takes place in the central control unit to determine the movements to be imparted to the frame 12 in order to insert the door D correctly in its door opening V. Upon completion of the processing, the robot arm 10b inserts the door D in its opening V (Figure 8).

After the door has been inserted in its opening, the two auxiliary television cameras 22 arranged beside the gripper frame 12 start to acquire data relating to the positions of the hinges 40. During this step, the free flange 40a of each hinge 40 is kept in contact with the body S by its shaped lever 36, operated by the jack 38. When the data relating to the positons of the hinges 40 has been acquired, the two welding robots 14 and 16 can start to weld the flanges 40a of the hinges 40 to the body S at 44 (Figure 9) according to a predetermined welding program.

Upon completion of the welding operation, the body S is moved from the first assembly station shown in Figures 1 and 2 to the second assembly station shown in Figures 3 and 4 where the steps described above for the rear doors are repeated for the front doors D_2.

During each cycle of the assembly robot 10, the gripper frame 12 is positioned on the calibration device 18 which has optical sights 18a for resetting the position of the frame 12 in space in order to avoid drift which might prevent the correct location of the doors. Moreover, the calibration or reference device may, to advantage, be associated with the storage rack M on which the doors are disposed.

Naturally, the method and equipment described above may be used for mounting doors on two-door vehicles and may have robots for automatically bolting the hinges 40 onto the motor-vehicle body S instead of the welding robots.

Naturally, it is intended that, the principle of the invention remaining the same, the details of construction and forms of embodiment may be varied widely with respect to those described and illustrated in the drawings, without thereby departing from the scope of the present invention.

Claims

1. A method of mounting doors automatically on motor-vehicle bodies, characterised in that it includes the following steps:
   - providing a robot (10) having an arm (10a) with grippers (12) associated with first (20) and second (22) televisual image-detection means,
   - locating the arm (10a) of the robot (10) in a reference position in front of a door opening (V) in a motor-vehicle body (S),
   - acquiring data relating to the position of the periphery of the door opening (V) by means of the first image-detection means (20),
   - taking a door (D, D_1, D_2) from a store (M) by means of the grippers (12, 26, 30) of the arm (10a) of the robot (10) ,
   - acquiring data relating to the position in space of the periphery of the door (D) relative to the grippers (12) by means of the first image-detection means (20),
   - processing the data resulting from the detection of the door opening (V) by comparing it with the data resulting from the detection

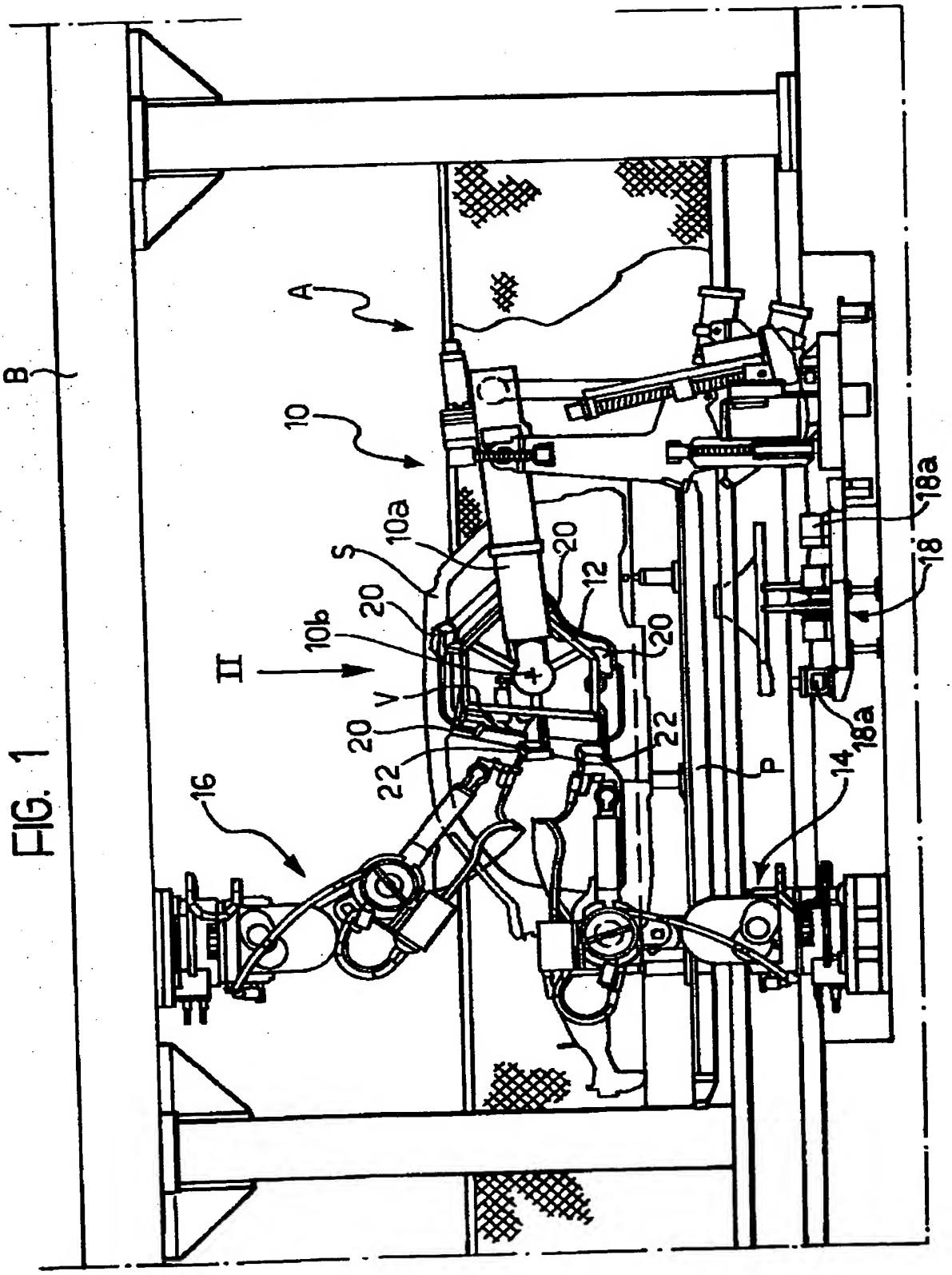
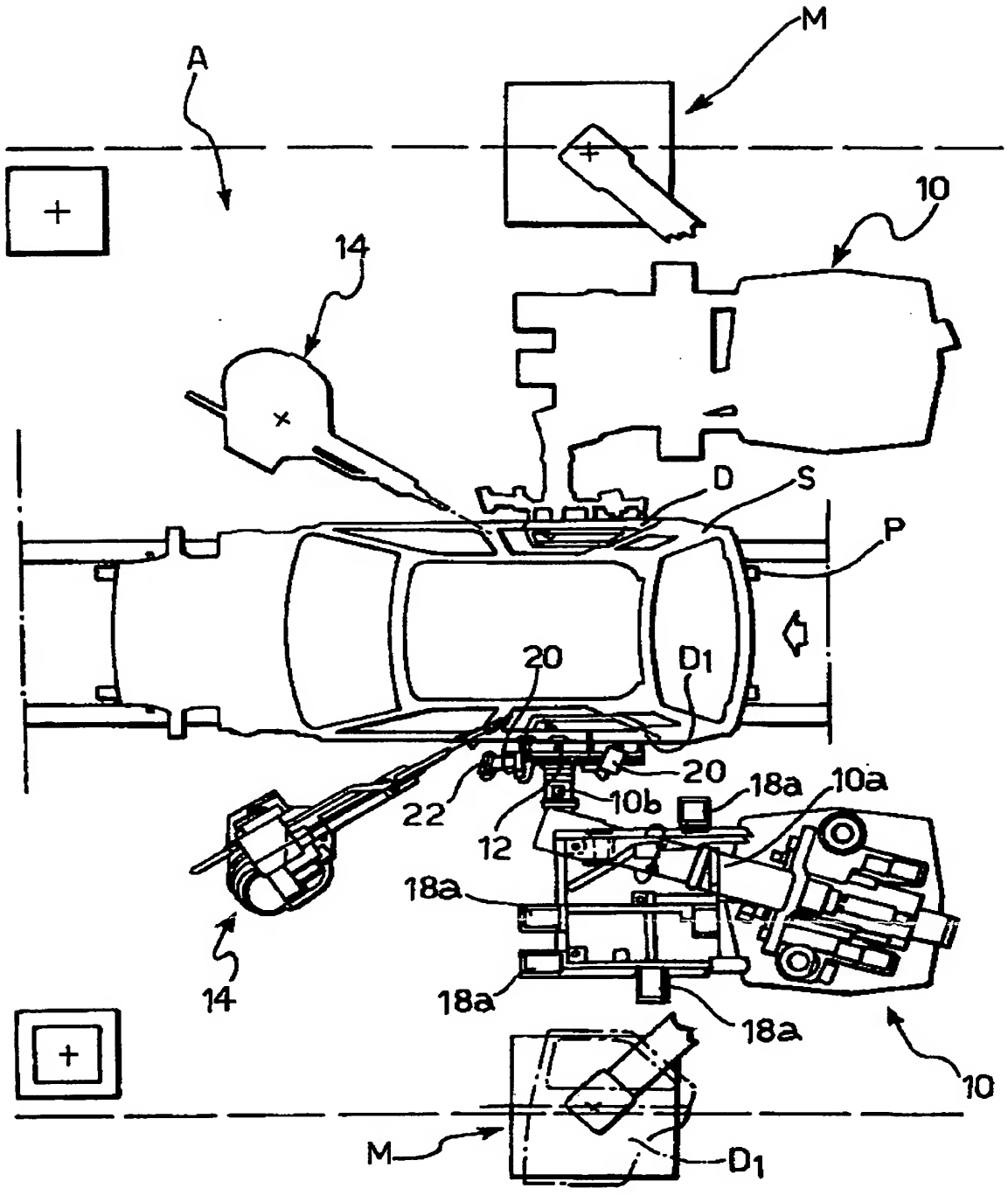


FIG. 1

FIG. 2



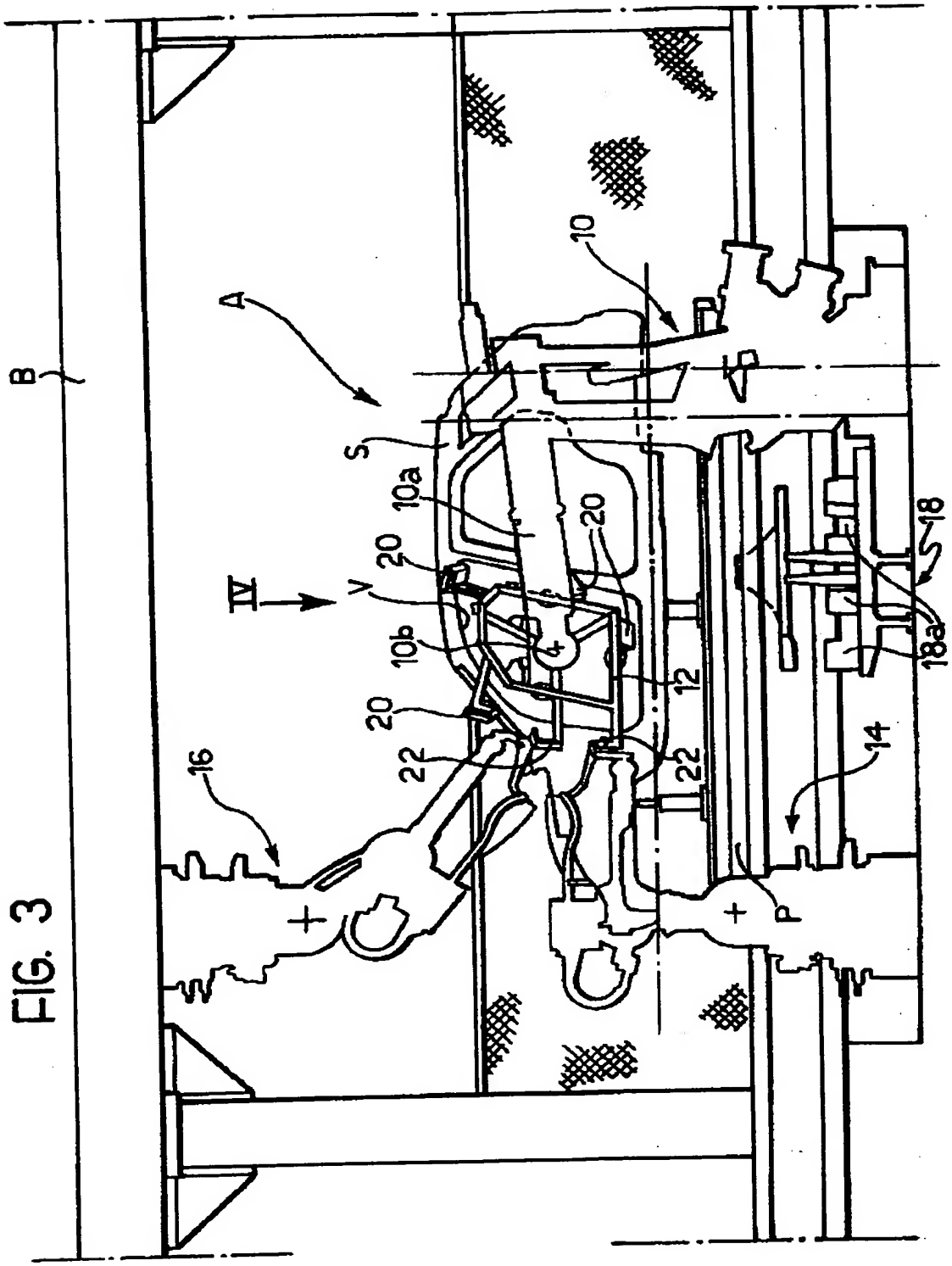


FIG. 3

FIG. 4

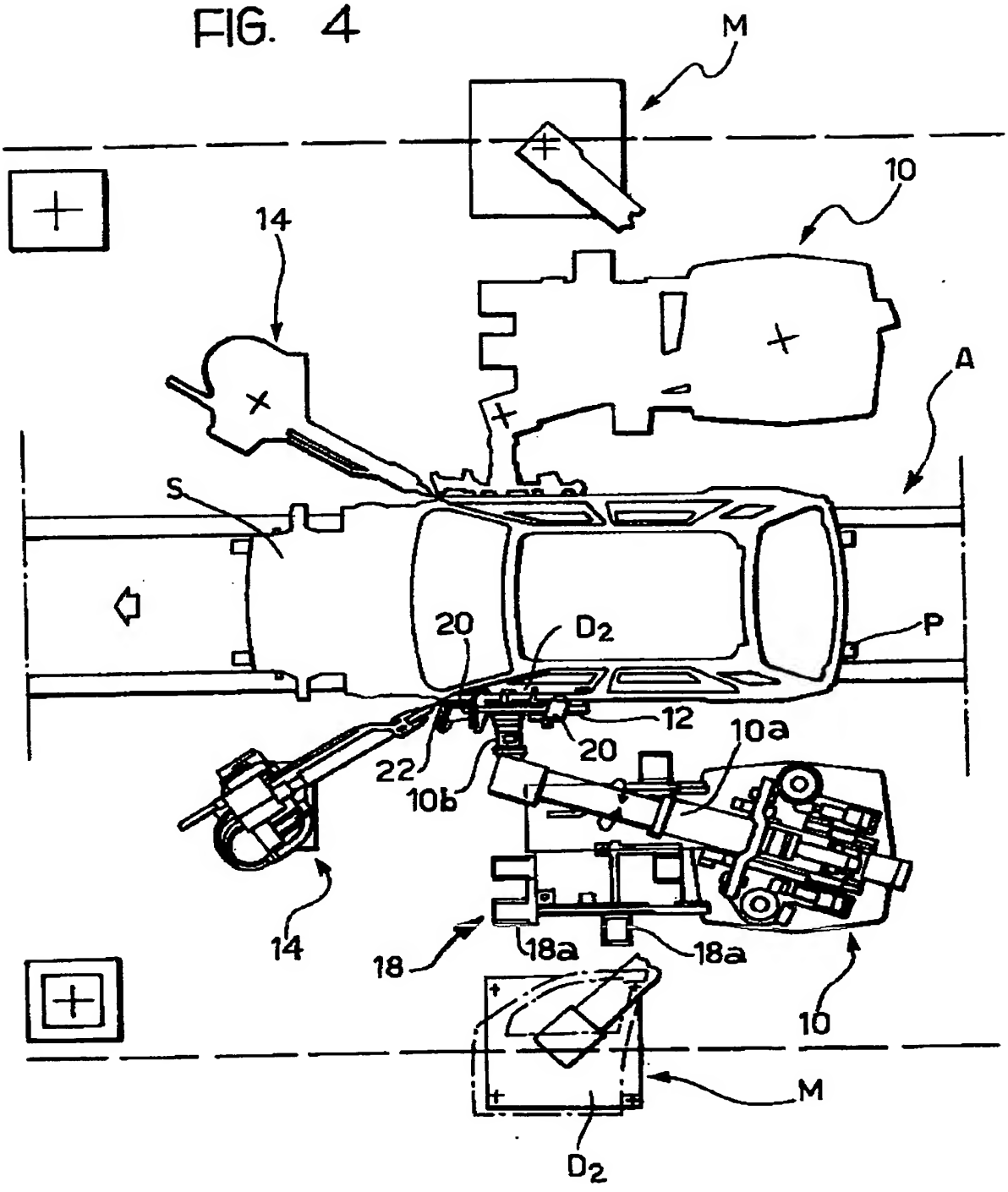


FIG 5

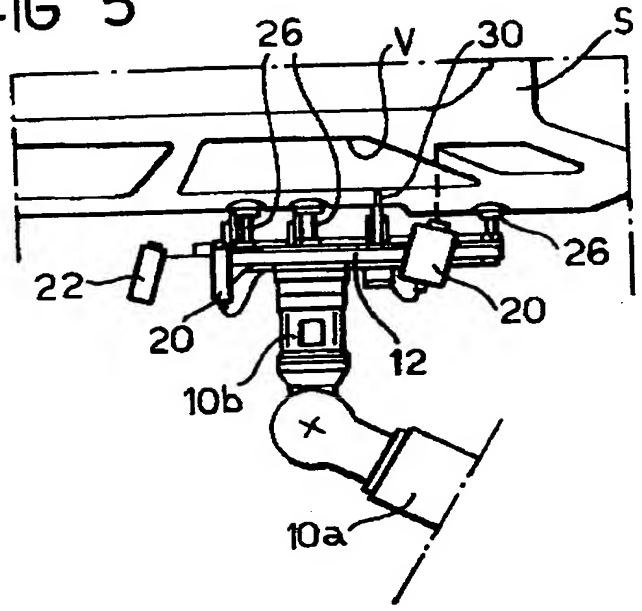


FIG. 6

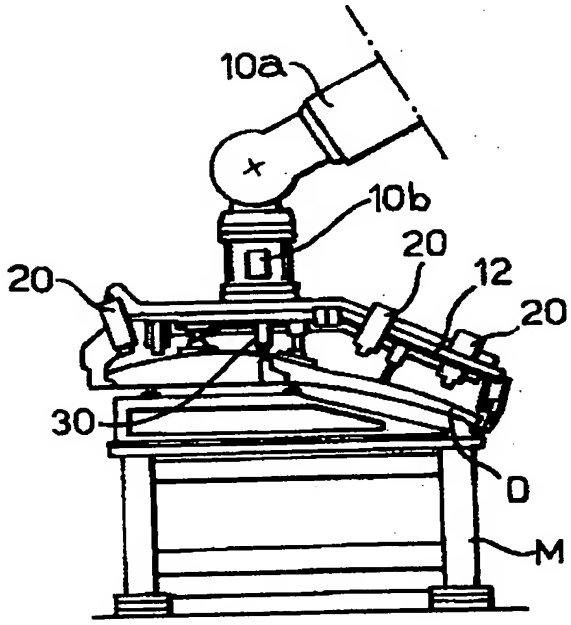


FIG. 7

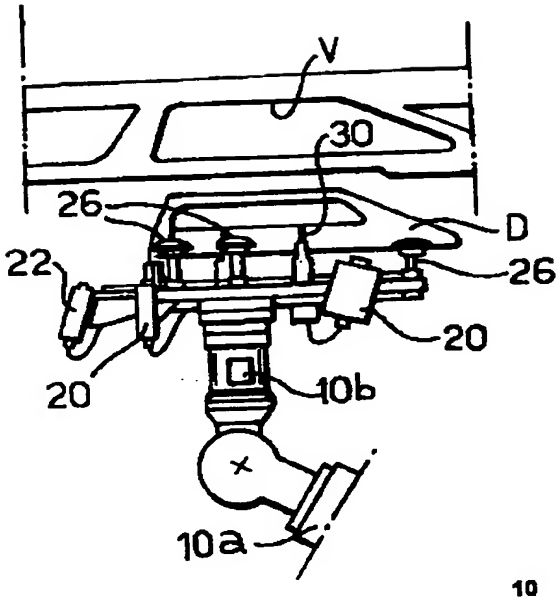


FIG. 8

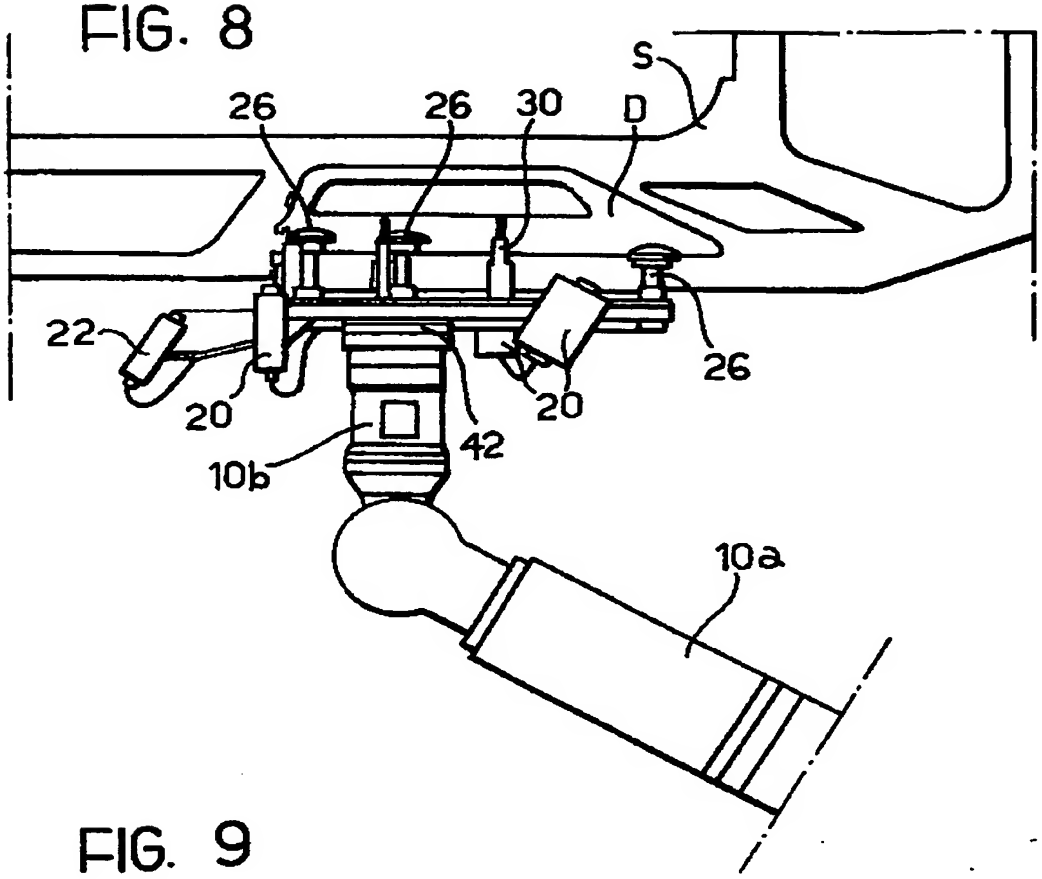


FIG. 9